

72'

INSTRUCTION MANUAL

Serial Number

 B070

176 PULSED HIGH CURRENT FIXTURE

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All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our plant, are warranted for the life of the instrument.

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PART I

OPERATION

Information necessary to operate the 176 in a Type 576 is provided in the operation part of the manual. This information is divided into two sections:

1. Specification
2. Operating Instructions

The first time operation procedure in section 2 allows a qualitative performance check of the 176 operation. For a quantitative check, see the performance check procedure in section 5.

Change information, if any, affecting this part of the manual will be found at the rear of the manual.

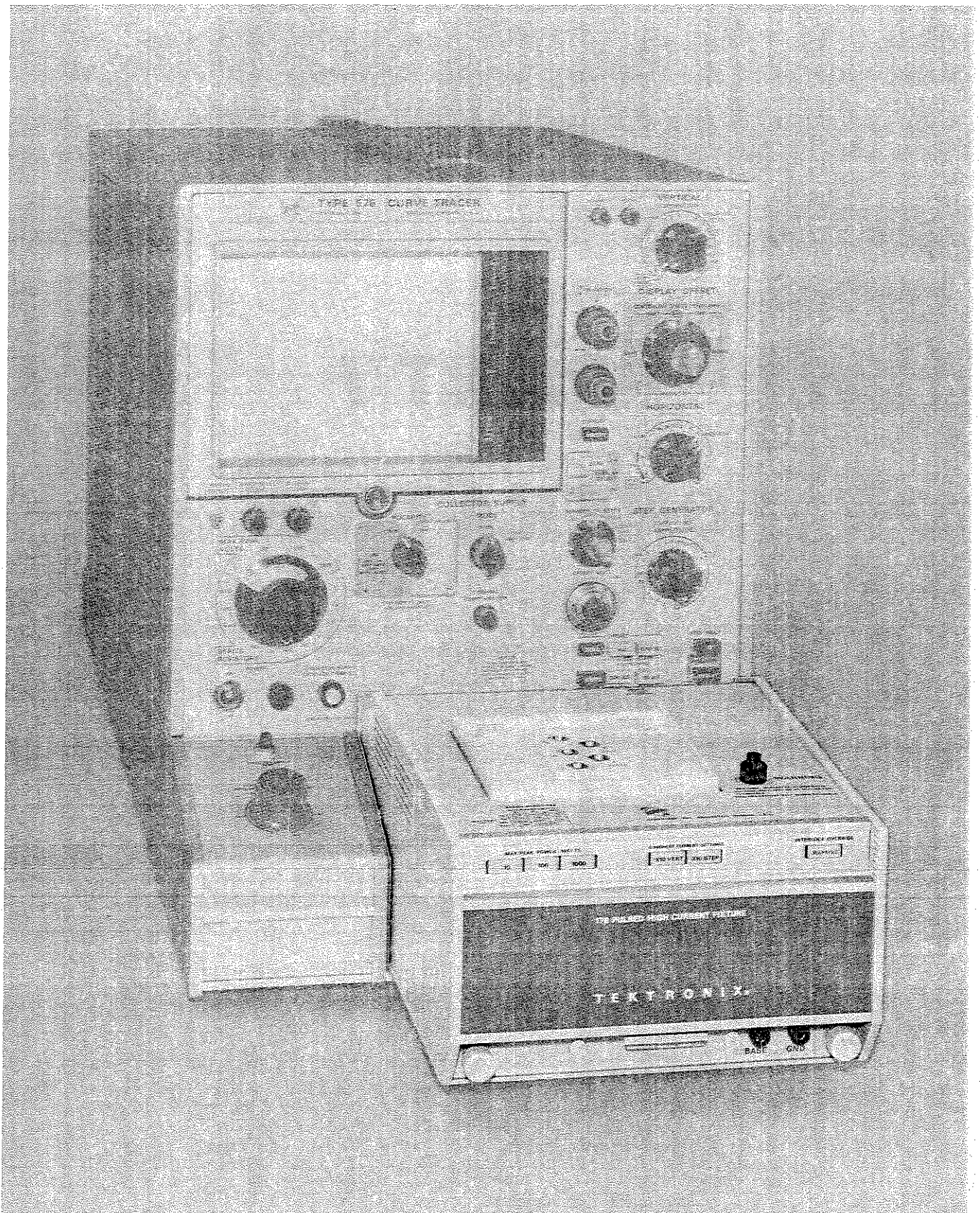


Fig. 1-1. 176 High-Current Fixture.

SECTION 1

SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

The 176 Pulsed High-Current Fixture extends the testing capability of the Type 576 Curve Tracer by providing a pulsed collector supply output of up to 200 A peak and a pulsed step generator output of up to 20 A peak. To accommodate this increased range, the maximum peak power output has been increased to 1000 watts and the maximum vertical deflection factor has been increased to 20 A/division.

The 176 slides into the Type 576 in place of the Standard Test Fixture. A set of 5 accessories jacks is available, which accepts most Tektronix device testing accessories. Kelvin sensing of collector voltage may be used for all tests. An interlock system is used, which allows tests to be made only when a protective box is in place over the device under test, thus protecting users from dangerous

voltages. For remote tests, this interlock system may be overridden by a front panel button.

The following electrical and environmental characteristics are valid for a 176 operated in a calibrated Type 576, both instruments operated in an ambient temperature of between 0°C and +50°C.

The electrical characteristics are listed in two categories, performance requirements and supplementary information. The Performance Check and Adjust section provides a procedure for checking the characteristics listed in the performance requirement category. The characteristics listed in the supplementary information category are provided for the convenience of the user. A performance check procedure for the Type 576 is available in the Type 576 Instruction Manual.

TABLE 1-1
ELECTRICAL CHARACTERISTICS

Characteristic	Collector Supply	
	Performance Requirement	Supplementary Information
Form of Output		300 μ s wide pulses. (80 μ s wide pulses also available but performance not specified.)
Repetition Rate		Power Line frequency
Polarity		Positive-going or negative-going as determined by Type 576 POLARITY switch.
Amplitude Ranges		15, 75 and 350 volts nominal, as determined by Type 576 MAX PEAK VOLTS switch.
Peak Voltage	Peak open circuit voltages within +25% and +5% of Type 576 MAX PEAK VOLTS switch setting for 75 and 350 positions; within +18% and -12% on 15 position. All at nominal line voltage.	

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplementary Information
Peak Current ¹	Minimum available peak current at low line into shorted load is: 200 A for 15 V range 40 A for 75 V range 8 A for 350 V range	
Pulse shape		
Flatness	Within 2% of peak collector supply voltage during display unblanking interval.	
Risetime		80 μ s (10% to 90%)
Falltime		10 μ s (90% to 10%)
Maximum Peak Power Output		1000 watts, 100 watts or 10 watts (Varies with line voltage).

Step Generator

Accuracy (Current steps and offset)		
Incremental accuracy		
X10 STEP button not illuminated		Refer to Type 576 Specification
X10 STEP button illuminated, 5 highest current settings only	Within 5% of 10 times Type 576 AMPLITUDE switch setting between any two steps without Type 576 .1X STEP MULT button pressed; within 10% of AMPLITUDE switch setting with .1X STEP MULT button pressed.	
Absolute Accuracy		
X10 STEP button not illuminated		Refer to Type 576 Specification
X10 STEP button illuminated, 5 highest current settings only	Within 3% of total output, plus 1% of ten times Type 576 AMPLITUDE switch setting, or 3% of ten times Type 576 AMPLITUDE switch setting, whichever is greater.	
Nominal Step Amplitudes		
X10 STEP button not illuminated		Refer to Type 576 Specification
X10 STEP button illuminated, 5 highest current settings only		Ten times (or one times with Type 576 .1X STEP MULT button pressed) Type 576 AMPLITUDE switch setting. Step amplitude is indicated on Type 576 PER STEP readout.

¹ Circuit breaker in Type 576 may open up if Type 576 VARIABLE COLLECTOR SUPPLY control has been left in its clockwise position for longer than 1/2 hour. It is advisable to leave the control in its counterclockwise position when not actually performing tests.

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplementary Information
Type 576 OFFSET MULT control range X10 STEP button not illuminated		Refer to Type 576 Specification
X10 STEP button illuminated, 5 highest current settings only		Continuously variable from 0 to 100 times Type 576 AMPLITUDE switch setting, either aiding or opposing step generator polarity.
Maximum Current in Current Mode (Steps and Aiding Offset) X10 STEP button not illuminated		Refer to Type 576 Specification
X10 STEP button illuminated	200 times Type 576 AMPLITUDE switch setting or 20 A, whichever is less.	
Maximum Voltage in Current Mode (Steps and Aiding Offset) X10 STEP button not illuminated		Refer to Type 576 Specification
X10 STEP button illuminated, 5 highest current settings only	At least 5 volts with Type 576 AMPLITUDE switch set to 10 mA, 20 mA, 50 mA or 100 mA; at least 2 volts with AMPLITUDE switch set to 200 mA.	
Maximum Opposing Voltage and Current Mode (Steps and Opposing Offset) X10 STEP button not illuminated		Refer to Type 576 Specification
X10 STEP button illuminated		Polarity of step generator output cannot be reversed using oppose offset.
Step Rate		Power line frequency; Type 576 .5X RATE button pressed by projection on 176 rear panel.
Pulse Characteristics Width		300 μ s (80 μ s width also available but performance not specified).
Duty Cycle (300 μ s pulsed steps)		Approximately 2%
Step/Offset Polarity		Same as pulsed collector supply polarity. Reversible by pressing Type 576 STEP/OFFSET POLARITY INVERT button.
Vertical and Horizontal Display Amplifiers		
Display Accuracies Horizontal		Refer to Type 576 Specification

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplementary Information
Vertical ² X10 VERT button not illuminated		Refer to Type 576 Specification
X10 VERT button illuminated, 5 highest collector current settings only	Within 3% of highest on-screen value when vertical display is unmagnified. When vertical display is magnified, within 4% with 0 to 10 divisions offset, 3% with 15 to 35 divisions offset and 2% with 40 to 100 divisions offset.	
Deflection factors Horizontal		Refer to Type 576 Specification
Vertical Collector Current X10 VERT button not illuminated		Refer to Type 576 Specification
X10 VERT button illuminated, 5 highest current settings only		1 A/division to 20 A/division in 1-2-5 sequence. Scale factor is indicated on Type 576 PER VERT DIV readout.

² Leakage (emitter current) measurements cannot be made when the 176 is being used.

TABLE 1-2
ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplementary Information
Temperature Non-operating	-40°C to +65°C	
Operating	0°C to +40°C	
Altitude Non-operating		To 50,000 feet
Operating		To 15,000 feet
Vibration (Non-operating)		15 minutes along each axis at 0.015 inch. Vary frequency from 10 to 50 to 10 c/s in 1-minute sweeps. Three minutes at any resonant point or at 50 c/s.
Shock (Non-operating)		30 g's, 1/2 sine, 11 ms duration, 2 shocks per axis
Transportation		Qualified under National Safe Transit Committee Test Procedure 1A

SECTION 2

OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

INSTALLATION

To install the 176 in the Type 576, turn off the Type 576, remove the Standard Test Fixture and slide the 176 into place. Projections on the 176 rear panel press the STEP FAMILY REP and .5 X RATE buttons on the Type 576 when the 176 is in place. To hold the 176 in place, tighten the two fixture-securing screws on the front of the 176.

COOLING

The 176 has the same operating environment requirements as the Type 576. A fan is provided in the 176 which draws cooling air in through the front of the fixture and blows it out through louvered holes on the sides.

CONTROLS, INDICATOR LIGHTS AND CONNECTORS

The functions of all the front panel controls, indicator lights and connectors on the 176 (see Fig. 2-1) are described in the following table.

MAX PEAK POWER-WATTS Buttons	Select peak power output of pulsed collector supply. Each button lights when pressed.
X10 VERT Button	When pressed, increases the deflection factor for the five highest current positions of the Type 576

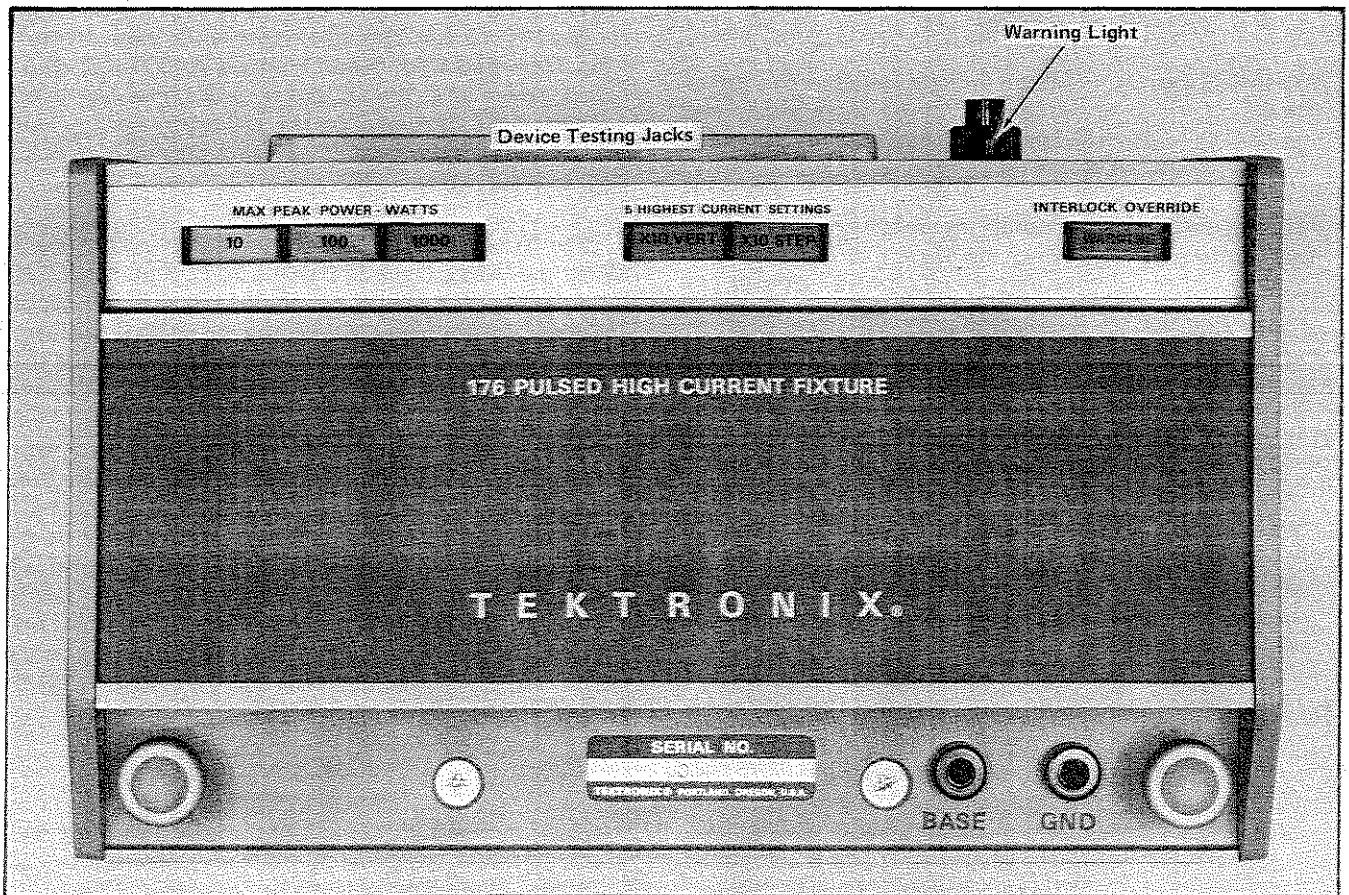


Fig. 2-1. 176 front-panel buttons, connectors and lights.

VERTICAL switch by 10. The PER VERT DIV readout indicates the new deflection factor. The button lights when pressed. The light goes out and the deflection factor returns to normal when the VERTICAL switch is turned clockwise beyond its five highest current positions.

X10 STEP Button

When pressed, increases the step amplitude for the five highest current positions of the Type 576 AMPLITUDE switch by 10. The PER STEP readout indicates new step amplitudes. The button lights when pressed. The light goes out and the step amplitudes return to normal when the AMPLITUDE switch is turned counterclockwise beyond its five highest current positions.

Interlock Switch

Enables the pulsed collector supply when the Type 576 COLLECTOR SUPPLY VOLTAGE DISABLED light is on. It is pressed when the protective box is in place and its lid is closed.

WARNING Light (Red)

When lit indicates that the pulsed collector supply is enabled, and dangerous voltage may appear at the device testing jacks.

INTERLOCK OVERRIDE Button

Enables the pulsed collector supply when the Type 576 COLLECTOR SUPPLY VOLTAGE DISABLED light is on. As a safety precaution, the action of the button is momentary.

WARNING

When the protective box is not in place, pressing the INTERLOCK OVERRIDE button makes operation of the instrument potentially hazardous. Operators should always be aware that dangerous voltages may appear at the device testing jacks when the red WARNING light is on.

Device Testing Jacks

Allow connection of Tektronix made 2, 3 or 5-terminal Test Fixture Adapters to the 176. The jacks also accept standard size banana plugs for remote testing. The jacks labeled C, D and E are collector, base and emitter jacks, respectively. The jacks labeled CSENSE and ESENSE allow Kelvin sensing of collector and emitter voltages.

BASE Jack

Base steps appear at this jack.

GROUND Jack

Provides external access to ground reference.

Ground Connector

A recessed sliding contact on left side of the 176, which grounds the 176 to the Type 576 chassis to prevent shock hazard.

GENERAL DESCRIPTION

The 176 High-Current Fixture extends the testing capabilities of the Type 576 Curve Tracer. Using the pulsed mode of operation, a device can be tested with pulsed currents of up to 200 amperes. Since these current pulses occur at a low duty cycle, a device can normally be tested without the use of heat sinks. Also, the chance of damaging the device is reduced.

Pulsed Collector Supply

The 176 pulsed collector supply produces current pulses which are either 300 μ s or 80 μ s in duration. These pulses are synchronized with the step generator output, and occur at line frequency rate (60 Hz or 50 Hz). The voltage amplitude of these pulses is determined by the Type 576 MAX PEAK VOLTS switch and VARIABLE COLLECTOR SUPPLY control. Three of the MAX PEAK VOLTS switch ranges (15, 75 and 350) are available for use with the 176. The Type 576 MAX PEAK POWER WATTS switch is disabled when the 176 is being used. The MAX PEAK POWER-WATTS buttons on the 176 provide power limiting of the pulsed collector supply. Power may be limited to 10, 100 or 1,000 watts.

The Type 576 interlock system is also used in the 176. When the yellow Type 576 COLLECTOR SUPPLY VOLTAGE DISABLED light is on, the pulsed collector supply is disabled. In this case either the protective box or the INTERLOCK OVERRIDE button can be used to enable the pulsed collector supply. The protective box fits over the device under test. When its lid is closed, the interlock switch is pressed, which enables the pulsed collector supply. Pressing the INTERLOCK OVERRIDE button also enables the pulsed collector supply. The INTERLOCK OVERRIDE button is used when the protective box cannot be used, either because the device under test is too large or it is in a remote location. Whenever the pulsed collector supply is enabled by the protective box or the INTERLOCK OVERRIDE button, the red 176 WARNING light goes on and the yellow Type 576 COLLECTOR SUPPLY VOLTAGE DISABLED light goes out.

WARNING

When the protective box is not in place, pressing the INTERLOCK OVERRIDE button makes operation of the instrument potentially hazardous. Operators should always be aware that when the red WARNING light is on, dangerous voltages may appear at the collector terminal of the device testing jacks.

Step Generator

When the 176 is being used, the Type 576 step generator must be operated in the pulsed steps mode. Using this mode, the step generator operates normally for all positions of the Type 576 AMPLITUDE switch except for its five highest current positions. The step amplitude for each of these five positions may be increased by 10 times by pressing the 176 X10 STEP button. The increased step amplitude is indicated by the PER STEP readout. With the X10 STEP button pressed, the maximum step generator output is 20 amperes. The X10 STEP button light will remain on until the AMPLITUDE switch is switched to a position below the 10 mA position. When the X10 STEP button light is out, the step generator operates normally.

NOTE

When the step generator is not in the highest 5 positions pushing the X10 STEP button will not change the step generator output but will change the readout.

Either 300 μ s or 80 μ s pulsed steps may be selected. If the Type 576 STEPS button is pressed, the 176 base step amplifier and pulsed collector supply are disabled. No damage results to the device under test.

When the X10 STEP button is illuminated, both the steps and the step offset, if any, are pulsed. Also, the range of the Type 576 OFFSET MULT control is increased, 10 times giving it a total range of 100 times the setting of the AMPLITUDE switch. When the X10 STEP button is not illuminated, only the steps are pulsed. In this case, the range of the OFFSET MULT control is 10 times the AMPLITUDE switch setting.

The step generator rate is always line frequency when the 176 is used, because a projection on the 176 rear panel automatically presses the Type 576 .5X RATE button when the 176 is installed. A similar projection presses the STEP FAMILY REP button.

NOTE

An open base condition can be obtained by setting the Type 576 step generator amplitude switch to .05 μ A.

Display Amplifiers

When the 176 is being used, the Type 576 display amplifiers operate normally, except that the X10 VERT button has been added to the 176 to add range to vertical measurements, and leakage measurements cannot be made. When the VERTICAL switch is set to one of its five highest deflection factors and the 176 X10 VERT button is pressed, the vertical deflection factor is increased 10 times. When the button is pressed, it lights and the increase in

deflection factor is indicated by the PER VERT DIV readout. When the VERTICAL switch is turned clockwise beyond its .1 A position, the X10 VERT button light goes out and the VERTICAL switch returns to normal operation. The X10 VERT button does not affect the positioning controls of the display amplifiers.

NOTE

When the VERTICAL DISPLAY FACTOR is not in the highest 5 display factors, the X10 VERT button will not change the vert display but will change the readout.

When the VERTICAL switch is set to STEP GEN and the X10 VERT button is pressed, a 50 amperes/division deflection factor is obtained. This deflection factor is not indicated on the PER VERT DIV readout and its accuracy is not specified.

Device Testing Jacks

Devices to be tested are connected to the 176 through the five Device Testing Jacks. These jacks allow one device to be tested at a time. Any of the Tektronix single-device test fixtures adapters can be plugged into these jacks. These adapters provide sockets into which devices with various lead arrangements may be placed for testing. Table 2-1 lists the test fixture adapters available for use with the 176 when this manual was prepared. (Others may now be available.) These jacks also accept standard banana plugs so that devices can be tested when it is inconvenient to use a particular device testing accessory, or when such an accessory is not available.

TABLE 2-1

Test Fixture Adapters Which May Be Used With the 176¹

Tektronix Part Number	Case Type
013-0072-00 ³	Diodes with axial leads (does not provide Kelvin sensing)
013-0100-00 ³	TO-3
013-0101-00 ³	TO-66
013-0110-00 ²	Diodes with stud leads; DO-4/DO-5
013-0111-00 ³	Diodes with axial leads (provides Kelvin sensing)
013-0112-00 ²	TO-36

¹This list contains only those test figure adapters available at the time this manual was being prepared. Additional adapters may now be available.

²Standard 176 accessory.

³Standard Type 576 accessory.

The jacks labeled C, B and E are the collector, base and emitter jacks, respectively. The jacks labeled C_{SENSE} and E_{SENSE} allow Kelvin sensing of voltages measured under high current conditions. Kelvin sensing means that current is supplied to a device under test through one set of contacts, and the voltage is measured through another set of contacts. This method of sensing voltage eliminates errors in voltage measurements due to contact resistance. C_{SENSE} and E_{SENSE} stand for collector sensing and emitter sensing, respectively.

EFFECTS OF 176 ON TYPE 576 CONTROLS

Since the 176 performs a specialized measurement function, some of the Type 576 controls, connectors and readout, do not perform the same functions as they would under normal operating conditions. The following table lists the Type 576 controls and their functions when the 176 is being used with the Type 576.

TABLE 2-2

Change in Function of Type 576 Controls, Connector and Readout When 176 is Used

Control	Change in Function
READOUT ILLUM	None
GRATICULE ILLUM	None
INTENSITY	None
FOCUS	None
VERTICAL	Leakage measurements can not be made; 5 highest deflection factors can be multiplied by 10 by pressing 176 X10 VERT button; STEP-GEN position provides 50 A/div deflection factor (with unspecified accuracy) when X10 VERT button is pressed.
DISPLAY OFFSET Selector	None
CENTERLINE VALUE	None
HORIZONTAL	None
POSITION (Vertical and Horizontal)	None
FINE POSITION (Vertical and Horizontal)	None

ZERO	None
CAL	None
DISPLAY INVERT	None
MAX PEAK VOLTS	1500 position is disabled.
MAX PEAK POWER WATTS	Disabled (MAX PEAK POWER WATTS buttons on 176 used instead).
VARIABLE COLLECTOR SUPPLY	None
POLARITY	AC position is not usable
MODE	May be set to NORM or DC (ANTI-LOOP). LEAKAGE (EMITTER CURRENT) position is not usable.
LOOPING COMPENSATION	Has no effect on display.
NUMBER OF STEPS	None
CURRENT LIMIT	None
AMPLITUDE STEPS/OFFSET	5 highest current step amplitudes can be multiplied by 10 by pressing 176 X10 STEP button.
OFFSET	When 176 X10 STEP button is lighted, offset is pulsed.
OFFSET MULT	When 176 X10 STEP button is lighted, the control becomes a 100 times multiplier.
STEPS	Not usable.
300 μs and 80 μs PULSED STEPS	None
STEP FAMILY	REP ON button is automatically pressed by plastic projection on 176 rear panel.
RATE	.5X button is automatically pressed by plastic projection on 176 rear panel.
POLARITY INVERT	None
.1X MULT	None
COLLECTOR SUPPLY VOLTAGE DISABLED Light	None

PER VERT DIV Readout	10 times multiplication is indicated when X10 VERT button is pressed.
PER HORIZ DIV Readout	None
PER STEP Readout	10 times multiplication is indicated when 176 X10 STEP button is pressed.
β OR g_m PER DIV Readout	None
CAMERA POWER Connector	None
Line Voltage Selector Assembly (Rear Panel)	None
50 Hz-60 Hz (Rear Panel)	None

FIRST TIME OPERATION

When the 176 is received, it is calibrated and should perform within the specification shown in Section 1. The following procedure allows the operator to become familiar with the 176 controls and their relationship to the Type 576. This procedure may also be used as a general check of the instrument's performance. For a check of the instrument's operation with respect to the specification given in Section 1, the performance check procedure in Section 5 must be used.

1. Install the 176 in the Type 576. Press the Type 576 300 μ s PULSED STEPS button.

2. Connect the Type 576 to a suitable power source and turn on the Type 576.

3. Allow the instruments to warm up for a few minutes. The instrument should operate within specified tolerances five minutes after the Type 576 has been turned on.

4. Set the 176 controls as follows:

MAX PEAK POWER-WATT	100
X10 VERT	Not illuminated
X10 STEP	Not illuminated
INTERLOCK OVERRIDE	Not pressed

5. Set the Type 576 controls as follows:

READOUT ILLUM	Visible Readout
GRATICULE ILLUM	Visible Graticule Line
INTENSITY	Visible Display
FOCUS	Centered
VERTICAL	50 mA
DISPLAY OFFSET Selector	NORM (OFF)
CENTERLINE VALUE	0
HORIZONTAL	5 V COLLECTOR
Vertical Position	Centered
Horizontal Position	Centered
DISPLAY INVERT	Released
MAX PEAK VOLTS	75
PEAK POWER WATTS	Has no effect
VARIABLE COLLECTOR	Fully Counterclockwise
POLARITY	+ (NPN)
MODE	NORM
LOOPING COMPENSATION	Has no effect
NUMBER OF STEPS	10
CURRENT LIMIT	20 mA
AMPLITUDE	0.5 μ A
OFFSET	ZERO
STEPS	Released
PULSED STEPS	300 μ s
POLARITY INVERT	Released
STEP MULT .1X	Released

6. Select an NPN power transistor with the following characteristics:

β	Between 20 and 50
I_c max	Greater than 10A
BV_{CEO}	75 V

Install the transistor in a suitable Test Fixture Adapter (TO-3, TO-36 or TO-66) and install the adapter in the Device Testing Jacks of the 176.

7. Put the protective box in place over the Test Fixture Adapter and close the lid.

8. Press the Type 576 ZERO button and adjust the spot to the intersection of the zero vertical and horizontal graticule lines of the CRT. Release the ZERO button.

9. Turn the Type 576 VARIABLE COLLECTOR SUPPLY control clockwise to obtain a collector-emitter voltage of 50 volts (10 divisions horizontally).

10. Set the Type 576 AMPLITUDE switch to 10 mA and adjust the VERTICAL switch for a display similar to

that shown in Fig. 2-2. (The VERTICAL switch should be set at one of its five highest current positions.)

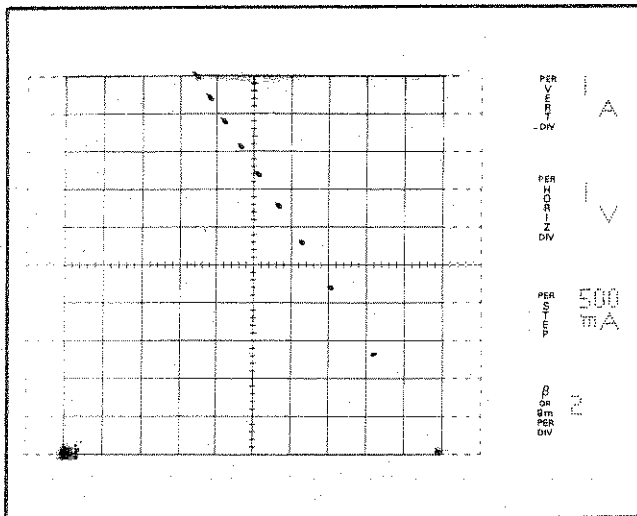


Fig. 2-2. Typical display of I_C vs V_{CE} for 10 different steps of base current for an NPN transistor.

11. Press the Type 576 OFFSET AID button and set the OFFSET MULT control for 2.00 (two steps of offset). Note that the zero step (or pulse) of the display is no longer on the zero horizontal graticule line. For normal pulsed base operation of the Type 576 (with the X10 STEP button not illuminated) the offset voltage or current is not pulsed.

12. Press the 176 X10 VERT button, which should illuminate the button. Note that the size of the vertical display is decreased by 10 times due to the 10X increase in the vertical deflection factor. The PER VERT DIV readout should also increase by 10 times.

13. Press the X10 STEP button, which should illuminate the button. Note that the size of the display increases due to the 10 times increase in the step generator step amplitude. The PER STEP readout should also increase by 10 times. Also note that the offset is now pulsed; thus, the pulses start from the zero horizontal line rather than from the offset level as discussed in step 11 for normal operation.

14. Lift the lid of the protective box. Note that the collector supply interlock opens and disables the collector

supply. This causes the red WARNING light on the 176 to go out, the yellow COLLECTOR SUPPLY VOLTAGE DISABLE light on the Type 576 to go on, and the display to disappear.

15. Leaving the lid of the protective box open, press the 176 INTERLOCK OVERRIDE button. This causes the collector supply to be enabled. Note that when the button is pushed, the yellow COLLECTOR SUPPLY VOLTAGE DISABLE light goes out, the red WARNING light goes on and a display re-appears.

WARNING

Pressing the INTERLOCK OVERRIDE button when the protective box is not in place enables the collector supply and makes operation of the instrument potentially dangerous. Operators should always be aware that when the red WARNING light is on, dangerous voltage may appear at the collector terminal.

16. Release the INTERLOCK OVERRIDE button and close the lid of the protective box.

17. Press the 1000 MAX PEAK POWER-WATTS button. Note that the maximum peak power being dissipated by the device under test (I_C versus V_{CE}) increases.

18. Press the 176 10 MAX PEAK POWER-WATTS button. Note that the maximum peak power decreases. Press the 100 MAX PEAK POWER-WATTS button.

19. Set the Type 576 AMPLITUDE switch to 5 mA. Note that the 176 X10 STEP button light goes out, and the step generator step amplitude is no longer multiplied by 10 times.

20. Set the Type 576 VERTICAL switch to 50 mA. Note that the 176 X10 VERT button light goes out, and the vertical deflection factor is no longer multiplied by 10 times.

This completes the first time operation procedure.

